THE ECLIPSE EXPEDITION AT VIZIADURG.[1]

II.

WITH regard to securing the best possible observations along all lines, the perfect organisation of time signals was of the first importance; indeed, a fundamental condition for success. The headquarter staff, under Captain Batten, was stationed at the eclipse clock, about which a word must be said. In an eclipse, especially when there are as many observers as we had on this occasion, it is well that every one shall know that he will get a good square look at it some time or other. In early eclipse work this was not recognised, and I never felt more annoyed in my life than, when I was in India, in 1871, I found that in consequence of my ignorance of eclipse organisation, Captain Bailey, of the Royal Engineers, who travelled 400 miles to our camp to help us, did not see the eclipse at all. He volunteered to give us the time, and took to rehearsing the work daily. I said to him, "What you have to do is to put your chronometer on the table and then sit down facing the sun, so that at any time you like during the eclipse you can look off the face of the chronometer and see the eclipse; because now you have come so far it won't do for you to go away without seeing anything." He said, "Well, I have been practising for the last two days, and I find it very difficult." I said, "What are you going to do about it?" He replied, "Well, I shall go on practising it till I do it." But to my horror, just before the eclipse began, I saw him take his chair to the other side of the table, deliberately place his back to the sun and look at the chronometer, and he never saw the eclipse at all. I was determined that that should never happen again in any eclipse that I had anything to do with, and since then I have always doubled the timekeepers, and given one-half of the eclipse to one timekeeper, and the other half to another. The "eclipse clock" is of rather peculiar construction. It only possesses a seconds-hand controlled by a seconds-pendulum. The face of the clock shows seconds, and a spiral on which the times are marked, so that there can be absolutely no mistake made as to the time. Not only can the even seconds be given in that way, but if a signal at any particular time is requisite for any particular operation in any of the observatories, the time signalman can give that time as well, so that all the operations are kept perfectly steady. The pendulum (and therefore the clock) is started by cutting a thread at the word "go," which means the beginning of the eclipse. Then one of the timekeepers turns his back to the sun, stands in front of the clock, and reads out the time-signals "120 seconds left," and so on, which are marked along the spiral, as the hand reaches them, while the other is looking at the eclipse. The half-time signal ("60 seconds" on this occasion) is sung out by both, and then they right-about face, one man going off duty and the other taking it up. In that way both see the eclipse. In order to give an idea of the importance of keeping the time during an eclipse, I will give our eclipse time table.

At 11 o'clock the "Thermometer" party commenced work.
11.12 a.m.—The "first contact" took place.
12.16 p.m.—"Naturalists and Landscape" party commenced operations and were followed at
12.30 p.m. by the "Slit Spectroscope and Prism" parties.
Ten minutes before "totality" Lieut. de Wet, with an Admiralty chronometer "gave the word," on which the "alert" was sounded on the bugle.
At this signal—
The "stops" were taken off telescopes.
Caps off siderostat and cœlostat.

[1] Continued from p. 233.

Clocks wound.
Timekeepers reported eclipse clock correct.
Observers at discs blindfolded.
Remainder of observers turned backs to sun.
Seven minutes before "totality" 3 "G's" were sounded on bugle as a signal to Prof. Pedlar with 6-inch.
25 seconds before "totality"—90° from Lieut. de Wet. 2 "G's" on bugle.
5 seconds before "totality"—45° from Lieut. de Wet. 1 "G" on bugle.
On the order "go" the first timekeeper, with his back to the sun, called out "127 seconds," and every 10 seconds till 17 seconds, followed by 10 seconds and 7 seconds, and then every consecutive second till "over" was given.

Why it was necessary to use the bugle will be seen at once. That was the order given to the various parties, several of whom, especially the disc observers, were a long distance from us. At the "alert" the stops were taken off the telescopes; a very wise precaution, for in some eclipses even caps have not been taken off at all—there were other things to think of! All the clocks were wound, and the observers at the discs were blindfolded. Then all the observers turned their backs to the sun in order that they might not weary their eyes by trying to see a series of phenomena of no interest to anybody. At 25 seconds before totality we had two "G's" sounded on the bugle. It had been determined that at that moment the uncovered arc of the sun measured exactly 90°. It was most important for the spectroscopic work that we should get a signal 5 seconds before totality—that is to say, 5 real seconds before totality quite independent of any errors in the *Nautical Almanac*. For the work of the prismatic cameras it was important to get a signal as nearly as possible five seconds before the beginning of totality, and, in order to eliminate the possible error of the chronometer, it was arranged to determine this by direct observations. Captain Batten did a thing which has certainly never been done in any eclipse expedition before. We expected, of course, a very definite shadow, and he was good enough to find a native dhow and charter it, and anchor it in the roadstead at such a distance that the shadow would strike it exactly 5 seconds before it struck the camp. For another signal we calculated that 5 seconds before totality the portion of the sun still visible would subtend an angle of 45°. The moment of totality was to be determined by means of the $3\frac{3}{4}$-inch.

THE WORK ATTEMPTED.

The Prismatic Cameras.

In the two prismatic cameras about sixty photographs were required, the exposures varying from one to fifty seconds. These included two series of ten snap-shots at the beginning of totality, and another ten at the end of totality, and shots of different periods, up to thirty-six seconds in one case, taken during the totality itself. That was done, of course, in the hope that one exposure would be better than any of the others, so that we should be sure of getting something at its best. Another reason was that we hoped to get records of fainter phenomena in the middle of totality than we were likely to do at the beginning and end of it. It was necessary to throw the sunlight into the camera by means of a mirror of a siderostat.

To carry out this programme of work, to secure the results required, a minute subdivision of labour was imperative. In the case of each of these two instruments six volunteers were employed, and they were distributed in the following manner:—

One observer with the finder, his duty being to keep the image in the centre of the field of view which corre-

sponded (by previous adjustment) to the centre of the plate in the prismatic camera. He had a timekeeper to record the times of contact.

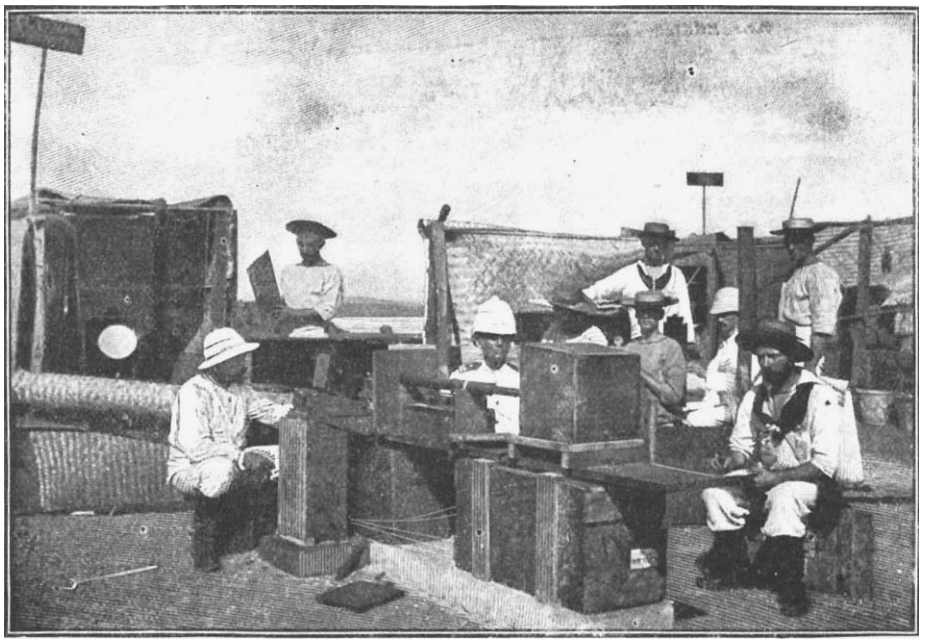

FIG. 4.—Six-inch prismatic camera.

A third acted as timekeeper to record the exact moments at which the exposures were begun and ended.

A fourth volunteer, by means of a piece of cardboard, covered and uncovered the front of the prism, from directions given by Mr. Fowler and Dr. Lockyer respectively.

In one case two, and in another three, men were required to hand and receive the large dark slides before and after exposure, taking them out of, or placing them back in, bags made for this purpose.

Six-inch Prismatic Camera.

This instrument, the dispersion of which had been increased by the addition of a second prism, was worked by Mr. Fowler, with the assistance of Lieut. de Wet and five men. Mr. Fowler's programme was to begin taking a series of ten snap-shot pictures five seconds before the commencement of totality, to obtain a record every second or thereabouts of the spectrum of the chromosphere. After this he exposed eight other plates to secure photographs of the coronal rings, the exposures being of various lengths. It was also arranged that at five seconds before the end of totality he should commence another series of ten snap-shots, exposing the last of these some few seconds after totality.

Nine-inch Prismatic Camera.

This instrument was in charge of Dr. W. J. S. Lockyer, who was assisted by Lieut. Percival Jones, R.N.R., and six men. This instrument was also fed by a siderostat, but the tube was not placed horizontally. It was intended with one of the prismatic cameras to so mount the tube that the arcs formed on the photographic plate should be symmetrical about the direction of dispersion, and it was decided that the .9-inch camera should adopt this plan of mounting.

The exact position of the tube to obtain this result was carefully determined by calculation. To facilitate the erection of the instrument at the station two wooden frames to carry the tube were previously made and taken out.

It is satisfactory to state that the photographs showed that the experiment was very successful, the arcs coming out exactly as forecasted.

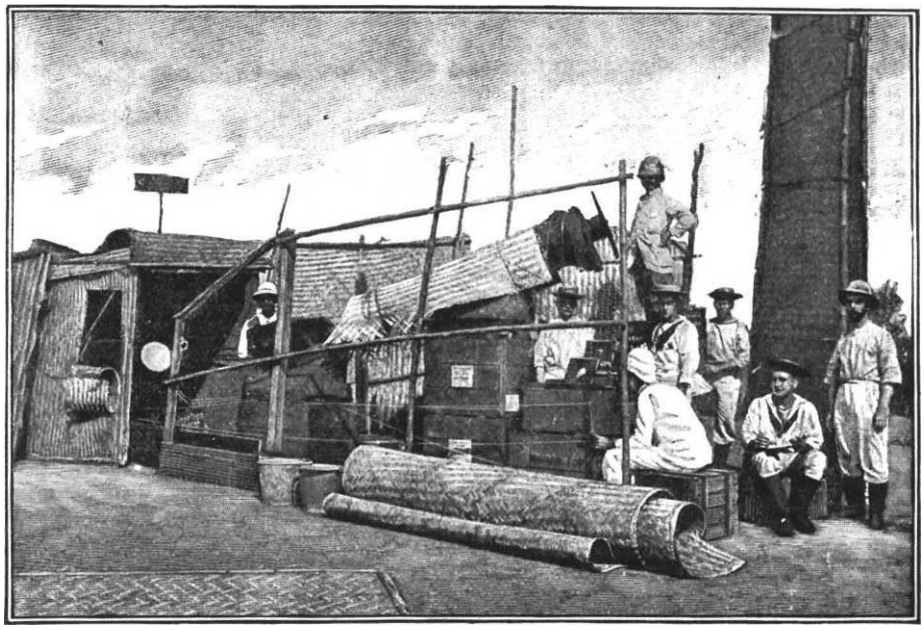

FIG. 5.—Nine-inch prismatic camera.

Although this instrument was capable of only giving

about half the dispersion of the 6-inch, the optical parts were better adapted for recording the ultra-violet region of the spectrum.

The programme adopted was similar to that of the 6-inch, there being two large plates ($16 \times 6\frac{1}{2}$) for recording a series of ten snap-shots at and near the times of second and third contacts, and nine smaller plates for exposure during totality.

Integrating Spectroscope.

This instrument consisted of a large collimator, two prisms of 60°, and a receiving camera. It was entrusted to the care of Lieut. G. C. Quayle, R.N., with two assistants. The light which fed this instrument was obtained from a cœlostat, and there was still sufficient room for another instrument to be utilised, so the coronagraph was set up in the same hut.

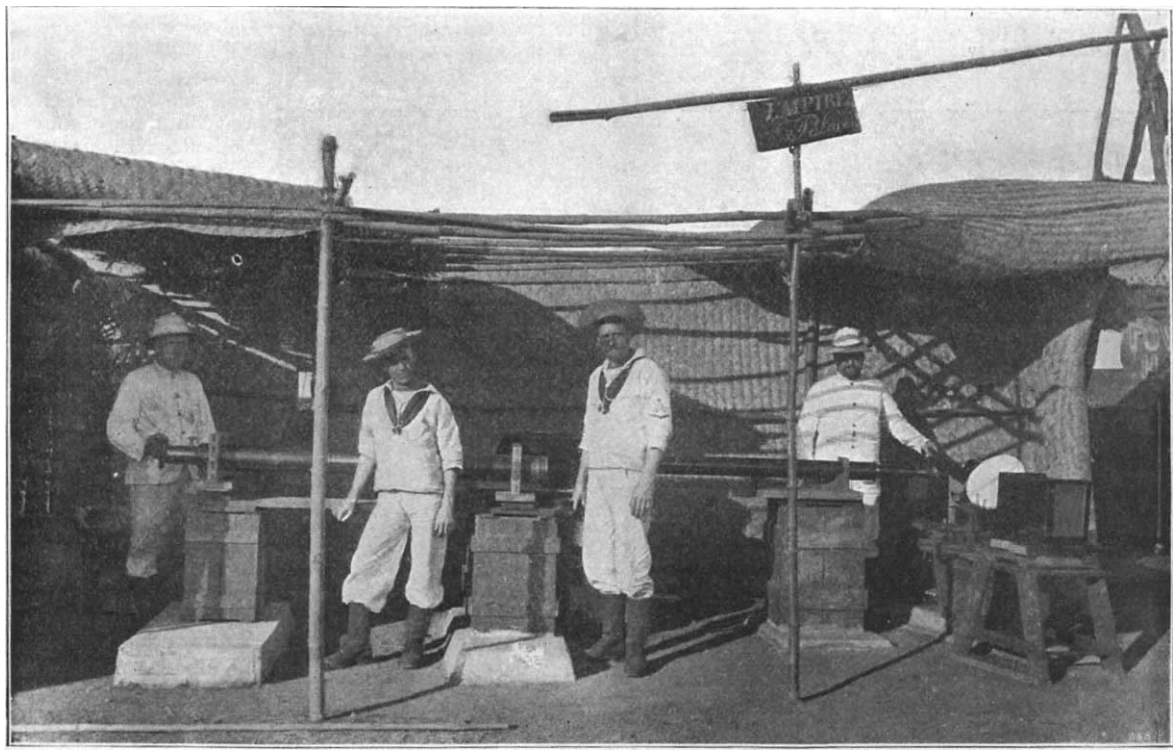

FIG. 6.—The coronagraphs and the integrating spectroscope.

Six-inch Equatorial with Grating Spectroscope.

This instrument consisted of a 6-inch lens mounted equatorially. The small grating employed contained 17,296 lines to the inch, and in the focus of the eyepiece was placed a small photographic spectrum of iron for comparison.

Prof. R Pedler, who came to take charge of this instrument, was assisted by Mr. Steele, R.N., gunner, and three other volunteers.

The Coronagraph.

We made no attempt to obtain any very fine photographs of the eclipse, because we knew that the Indian observers would do that. But it was necessary to get some photographs which would give us the relationship between the different parts of the corona which we saw and those photographed by means of other instruments. The chromosphere and coronal rings we especially hoped to get in the prismatic cameras. The instrument employed, of $4\frac{3}{8}$-inch aperture, was entrusted to Staff-Engineer A. Kerr, R.N., who was assisted by three volunteers from the engine-room staff.

There being still a small amount of available surface of the cœlostat for other purposes, this was utilised for the 10 × 8 landscape camera, which was operated by Mr. Turner.

Discs.

The discs, six in number, were put into position by Lieut. G. C. Quayle, R.N., and Lieut. C. E. B. Colbeck, R.N., being ranged along the southern wall of the fort, close to the Eclipse Camp. The great altitude (53°) of the sun rendered the operation of setting them up somewhat difficult. Their sizes varied from six to two inches, and they were so placed that they cut off 3,'5, and 7 minutes of arc round the dark moon.

Each disc occupied the time of three men, so that in all eighteen volunteers were employed. Of each party of three, one volunteer kept the eye end in adjustment up to the time of totality, another who was blindfolded ten minutes before totality acted as observer, and the third wrote down the remarks of the observer.

The $3\frac{3}{4}$-inch Equatorial Telescope.

This telescope was used by me to observe the exact time of second and third contacts to give the signals "go" and "over" to the timekeepers. For the first fifty seconds of totality I employed this instrument myself to minutely observe the structure of the rifts and streamers. In my absence it was used by Assistant Engineer H. H. Willmore, R.N., for the examination of the structure of the corona.

Star Observations.

I will pass from the larger instruments and come to the star observations. These observations were entirely

in charge of Lieut. Blackett, R.N., and what he did every night before the eclipse was to get his staff of seven or eight to observe certain groups of stars from the deck of the ship or from the shore, and determine their magnitudes as well as they could, and make maps of them. It was perfectly wonderful how, after three or four nights, they could make a map of the constellation of Orion, not going very far wrong. That stood us in very good stead during the eclipse.

Each observer was supplied with a photograph of a small star chart of the region near the sun, prepared by Dr. Lockyer. This was afterwards supplemented by another on a larger scale photographed at the office of the Trigonometrical Branch of the Survey of India at Dehra.

Observations of Shadow Bands.

Staff-Surgeon Nolan, R.N., observed these phenomena with the help of two assistants. Previous to the eclipse a large white table-cloth was spread on a flat piece of ground in front of two walls intersecting at an angle of 115°, which were whitewashed.

FIG. 7.—The kinematograph hut.

Small Prism and Grating Observations.

The spectroscopic work was in charge of Lieut. Colbeck, R.N., and Senior Engineer Mountifield, R.N. I took out several spare prisms and spectroscopes with me in the hope they would be of service, and they were used to the very great advantage of science.

Meteorological Observations.

Mr. Eliot, the Meteorological Reporter to the Government of India, brought with him several important instruments with a view of making observations similar to those he had arranged along the whole line of totality. He was assisted by twelve volunteers.

Landscape Cameras and Kinematographs.

All the available landscape and hand cameras were put in charge of Mr. Turner, of the Survey Department, Calcutta, who was assisted by five volunteers.

As a well-defined shadow had been anticipated, the kinematograph was used for the first time in an attempt to photograph its passage through the air.

The Marquis of Graham brought out with him two kinematographs, one for the recording of the whole phenomenon of the eclipse, and the other for photographing the moon's shadow as it swept across the earth's surface. The latter was put in charge of Mr. H. P. Barnett, R.N., Paymaster, with one assistant. The kinematograph for the eclipse was worked by the Marquis of Graham himself, and five volunteers. The instrument was fed by a small cœlostat.

The above statements will give an idea of the completeness of the organisation rendered possible by such a wealth of observers, and it is to be hoped that the example set in 1898 may be followed in the eclipses of this and the following years. NORMAN LOCKYER.

THE YANGTZE VALLEY.[1]

MRS. BISHOP'S volume gives an account of a journey undertaken, the author tells us, solely for recreation and interest after some months of severe travelling in Korea. The book is a valuable contribution to the literature of travel, both from the remarkable personality of the writer and from the public interest recently directed to our projected "sphere of influence" in the Yangtze Valley. The greater part of the route followed has become a "beaten track" for travellers who from time to time have recorded their experiences and supplied valuable statistical accounts of the potentialities of this part of China. The author, however, in her daring attempt to reach the heart of the Mantze country, entered upon new and untrodden ground, and has given a graphic account of her adventures in one of the most picturesque mountain lands of China, the home of this obscure aboriginal tribe.

The story is all the more fascinating because it is written by a woman who has been careful to note the details of her environment day by day in a manner quite her own, and always interesting. Some light has been thrown upon this race of mountaineers, who, physically and in their manners and customs, are a people apart from the Chinese, who have maintained their characteristics, their language, and their independence through the centuries, and at last have been driven by their foes to the mountain solitudes of Szechuan and other parts of the empire.

It is to be regretted that Mrs. Bishop was unable to add to her excellent series of photographs some types of the race, or to afford some clue to the language, which appears to be an unknown tongue written in Tibetan characters. They are, one would suppose, allied to the Sifan and Lolo visited by Baber.

The first chapter deals with the Yangtze Valley—our sphere of influence. Approximate figures are here set

[1] "The Yangtze Valley and Beyond." By Mrs. J. F. Bishop. Pp. xv + 557. (London: John Murray, 1899.)